ISO TC 163/WG2
Thermal Transmission Properties of Windows
MINUTES
Meeting at Versuchsund forshungsanstalt der Stadt Wein, Magistratsabteilung 39 Vienna, Austria 8-9 May 2000

1- Welcome and introduction: The meeting was called to order at 09:30 on Monday, 8 May 2000 by Mr. Frank who substituted for Mr. Elmahdy until Mr. Elmahdy arrived (due to flight delays). Mr. Kuhnert and Mr. Fleck welcomed the members and guests to the Versuchsund forschungsanstalt der Stadt Wein, Magistratsabteilung 39 in Vienna (Wien), Austria.

2- Regrets: Mr. Elmahdy received regrets from members Mr. Cammerer, Mr. Jonsson, Mr. Kimura and Mr. Nothe.

3- Review of the membership list: Mr. Elmahdy circulated the most recent membership list (N 234) from the ISO/TC 163 Secretariat. Members were asked to add their e-mail addresses to the list. It was noted that the information from Mr. Svendsen once again needs to be corrected. **Mr. Elmahdy will inform Ms. Andersson about all corrections and changes to the Master Mailing List.**

4- Berlin meeting minutes: Mr. Elmahdy reviewed the minutes from the Berlin meeting (N 235). The minutes were accepted with the correction of the spelling of Mr. Wright's name on page 9.

5- Summary of WG2 report to TC163 in Berlin, September 1999: Mr. Elmahdy discussed the ISO/TC163/WG2 report (N 232) that was presented at the ISO/ TC 163 meeting in Berlin in April, 1999.

6- Review of action items from last meeting: Mr. Elmahdy reviewed the seven action items on ISO/DIS 15099 listed in part 13 of the Berlin meeting minutes (N 235).

On the first item, see the item on the letter to be written by Mr. Williams below.

On the second item, Mr. Wright prepared a glazing comparison table (N 239) to illustrate the difference between ISO/DIS/15099 and prEN ISO/FDIS 10077-1.

On the third item, **Mr. Williams will again contact Mr. Anderson to get the latest ISO/FDIS 10077-1 table on glazing U-values.**

On the fourth item, **Mr. Curcija will provide the frame calculations in tabular form using ISO/DIS 15099 for the entire prEN ISO/DIS 10077-2 Annex D profiles on Tuesday, 8 May 2000.**

On the fifth item, Mr. Svendsen reported that it did not appear to be possible to incorporate ISO/DIS 15099 into the WINISO program.

On the sixth item, Mr. Svendsen previously reported (N 233) on the comparison of calculated and measured U-values for five different fenestration systems. Additional information is reported in N240.

On the seventh item, Mr. van Dijk reported that he had prepared the summary of the validation study for the proposed shading system methodology and presented it to WG2 at the Berlin meeting.

On the eighth item, the work of Mr. Van Dijk (see the seventh item above) addressed the comments and questions by Mr. Curcija.

4- Review of outstanding issues:

i- film heat transfer coefficient: Mr. Goss reported that Mr. Kimura had made editorial revisions to Section 8.2.2. Convective Heat Transfer Coefficient – Outdoor Side (N 237). Mr. Goss also discussed that this section should address three different possible application areas for ISO/DIS 15099. The first is for product rating purposes where constant convection heat transfer coefficients are currently used. The second is for comparison with hot box U-value measurements (e.g., ISO/FDIS 12567) where local surface convective heat transfer coefficients are more appropriate. Mr. Goss presented some of the classical flat plate local convective heat transfer correlations for parallel and impinging (perpendicular) flow directions. Ongoing work is being carried out to include the effects of stagnation and separation/reattachment regions in the areas where the frame profiles change from vertical to horizontal and horizontal to vertical surfaces. The third potential application area is for annual energy use calculations where the work of Mr. Kimura on real buildings (N 237) is more appropriate. Mr. Goss agreed to draft a revised Section 8.2.2 to include these three applications areas along with the recommended convective heat transfer correlations and references. **Mr. Goss will provide the revised Section 8.2.2 by the end of May, 2000.**

ii- gas fill properties: Mr. Goss reported (N 238) on the revised Annex B tables for fill gas thermophysical properties. The revisions addressed the comments of Mr. Wright on the accuracy of the air properties. The revised tables now give referenced gas fill thermophysical property data.

iii- sloped glazing in ISO 10292: Mr. Curcija and Mr. Wright stated that no work has been done on this item and that no work is planned for the near future.

iv- U-value comparison between ISO/DIS 15099 and a table in prEN ISO/FDIS 10077-1 based on EN 673: Mr. Wright reported (N 239) that the differences between the two methods were greater for low emittance glazing units where the differences between the glazing cavity convective heat transfer correlations are more important. Mr. Svendsen (N240) and Mr. Williams (N169) had previously shown that the glazing cavity heat transfer coefficient correlation used in ISO 10292 and prEN ISO/FDIS 10077-1 (based on EN 673) gives lower glazing U-values (U_g) that are not validated by window experimental measurements. It was subsequently recommended by WG2 that **Mr. Williams draft a letter with supporting tables and figures from N239 (updated as necessary by Mr. Wright) for Mr. Elmahdy to send to CEN TC 89 and ISO TC 160 through the ISO TC 163 Secretariat** pointing out this fact. The letter will include the recommendation that the glazing cavity convective heat transfer correlations in ISO/DIS 15099, that were validated by N240 and N169, be used.

Before sending the above letter, Mr. Elmahdy will contact the convenor of TC 160/SC1/WG2, Mr. Nothe, to see if it is possible to get the current revised draft of ISO 10292. If provided, Mr. Elmahdy will review the revised draft of ISO 10292 to see if any changes to the inappropriate glazing cavity convective heat transfer coefficient correlation have been made. If no revised draft is received, or no changes have been made in the revised draft of ISO 10292, Mr. Elmahdy will send the above letter to the TC 163 Secretariat to be forwarded to CEN TC 89 and ISO TC 160.

v- difference between ISO and ASHRAE calculations: Mr. Svendsen reported (N241) the results of U-value calculations for a double glazed, wood window. The edge (ASHRAE) and lineal (CEN/ISO) U-value calculation methods using an edge-glass distance of 63.5 mm gave incorrect results, since the 63.5 mm distance did not capture all of the frame/edge two-dimensional effects. Using an edge-glass distance of 150 mm distance in the frame/glazing and frame/insulation panel heat transfer calculations, the overall two-dimensional U-values for different size windows were calculated. In addition, three-dimensional heat transfer calculations were made for the window corner region and point correction factors were determined that could be applied to the two-dimensional U-values to have them agree with the three-dimensional heat transfer results. Mr. Svendsen indicated that it is probably not feasible to perform three-dimensional heat transfer calculations on all of the windows that are analysed using conventional two-dimensional U-value calculational computer programs. Mr. Goss also indicated that additional three-dimensional effects due to the more complex convective and radiation heat transfer in the window corner regions are not addressed in the current two-dimensional computer programs.

Mr. Goss next presented the preliminary results of Mr. Blanusa's M.S. Thesis in which ASHRAE (edge) and ISO (lineal) U-value calculations were performed for an aluminium frame window for the same overall window sizes studied in Roth (N 213). The results again showed that the ASHRAE U-values were lower than the ISO U-values, but when rounded off to two significant figures, the two U-values agreed for the larger windows, and only differed by 0.1 W/m^{2}K for the smaller windows which may only be typical for true divided lite windows. In addition, it was shown by comparing the algebraic assembly of the two U-values for a window that had the same frame profile on all sides, the difference can be shown by a simple algebraic result:

$$U(ASHRAE) - U(ISO) = \left[U_f(ASHRAE) - U_f(ISO)\right]\left(4\lambda_f^2\right) - \left[U_{edge}(ASHRAE) - U_g(ISO)\right]\left(4\lambda_{edge}^2\right)$$

Mr. Goss then showed that by using the calculated two-dimensional frame, edge and glazing U-values given in N241, the above simple algebraic equation gave the same difference as the calculated differences presented in N241.

Based on the above presentations, Mr. Goss and Mr. Svendsen then presented the following conclusions and recommendation.

Conclusions

- Different results are obtained from the two methods (not good for an ISO standard)
- The differences are quite small for larger windows but become greater for smaller windows (true divided lites)
- Manufacturers will probably use the method that gives the lower U-value
- Several CEN countries need U_f values (i.e., for comparing frames only)

Recommendation

That ISO/FDIS 15099 use the lineal method only

Note: Initial drafts of ISO/CD 15099 had lineal method only based on the recommendation of D. Arasteh (LBNL) at the Delft WG2 meeting.

vi- comparison of U-value calculation using CEN and ISO methods

Mr. Svendsen gave a presentation on DTU Report SR-0010, February 2000, "Analysis of Calculated and Measured Energy Properties of Windows" by K. Duer and S. Svendsen (N240). The results indicated that EN673 gives incorrect U-value results for wider, low-e glazing cavities when convection heat transfer effects are important when compared with experimental measurements. More detailed glazing cavity convection heat transfer correlations, like those currently in ISO/DIS 15099, compared much better with the experimental measurements.

Mr. Feldmeier presented the results (including the revised results from Mr. Jonsson and Mr. Standaert (N244) and the recent results from Mr. Van Dijk (N257)) of the comparison calculations on frame sections in connection with prEN ISO 10077-2 (N243). The average of the participating laboratories will be given in Annex D3 of prEN ISO 10077-2. The revised Table D.3 will be sent out to all of the laboratories for final checking. Comments on the table data and any editorial/clarification comments should be returned to Mr. Hartmann by the end of May, 2000.

On the second day of the meeting, Mr. Feldmeier passed out a revised summary table similar to that given in N243. **Mr. Hartmann will send to Mr. Elmahdy a revised version of N243rev with this revised table.**

The revised document prEN ISO/FDIS 10077-2 will then be sent out for joint CEN/TC89 and ISO/TC163 registration and ballot.

vii- new items for discussion from ASHRAE SPC 142P

Mr. Curcija showed a list of eight items that came up at the most recent ASHRAE SPC 142P meeting:

1) Change wording in geometric representation section:

- On page 20 , Sentence that starts with "More specifically, those segments…"; create a new paragraph and delete "More specifically", so that it starts with "Those segments…"

- Add 5th criteria: The endpoints of the segment preserve their relative position ± manufacturing tolerances. Each change in slope or radius shall be considered a new segment subject to the requirements in this paragraph.

2. Gas properties: Clarification on the source of this data, and why is there discrepancy for some data.

3. Radiation calculation to the indoors: The alternative method proposed by John Wright.

4. Outdoor convective surface heat transfer coefficient: New correlations proposed, but they were derived from field conditions, not laboratory conditions.

5. Frame cavities: add language for partially ventilated cavities.

6. Conductivity values: Find original CEN list.

7. Treatment of sloped boundaries: Formula gives values that are artificially lower near thermal bridges.

8. Complete alternative method for calculating SHGC of frames.

Several of these items had been addressed in the previous discussions. Mr. Elmahdy recommended to Mr. Curcija that the other items be added to the member body comments on the current ISO/DIS 15099 ballot so that they can be more fully addressed at the next WG2 meeting.

There was an extensive discussion of item 3 – concerning the presence of a detailed radiation model proposed by Mr. Curcija as well as a simplified radiation model proposed by Mr. Wright. Mr. Curcija spoke to summarise his technical papers and asserted that these papers provide validation for the detailed radiation model that he added to the document in Boras.

Mr. Wright offered the opinion that the papers provided by Mr. Curcija do not provide validation for the detailed model. Further, he reiterated that he feels that work presented in his own technical paper (N251) not only (a) explains the basis for the simplified model but also (b) shows a comparison with the more detailed model, (c) supplies commentary on the merits of the two models and (d) points out that neither model can be validated or refuted experimentally until more information is uncovered about the convective heat transfer coefficients that apply to projecting products.

Mr. Curcija suggested that the simplified model is technically deficient, but noted his willingness to accept the presence of two alternative methods.

Mr. Curcija and Mr. Shah presented many arguments in favour of the detailed model and against the simplified model.

Mr. Svendsen pointed out that the comparisons presented by Mr. Curcija included many other effects, including uncertainties in convection, so a more direct comparison is required. Mr. Williams echoed these comments.

In order to move on to other issues, **the members were all encouraged by Mr. Elmahdy to read the four technical papers related to the indoor radiation exchange models for projecting products, to digest the information and to**

come to the next meeting prepared to participate in the continued discussion.

viii- vertical frame cavities: In Section 6.6, Effective Conductivity – Frame Cavities, Section 6.6.3, Horizontal Heat Flow, it is recommended that for jamb frame sections, clause b, for $L_v/L_h>5$, the recommended correlation, Equations (80) to (82), be used. It is believed that this correlation applies for high aspect ratio cavities in both the vertical and horizontal directions. Jamb frame cavities are normally only high aspect ratio in the vertical direction and are more close to a unity (square) aspect ratio in the horizontal direction. Mr. Wright indicated that it is not known if the current correlation applies to tall narrow jamb frame cavities. Mr. Curcija stated that some work was being done in Norway (Norwegian University of Science and Technology) and the United States (LBNL) to address this issue. If this work were in a form useful to ISO/DIS 15099, it would be presented for consideration at the next WG2 meeting.

5- Review of the draft of ISO/DIS 15099 standard. Mr Elmahdy stated that no changes could be made to the document at this meeting since it was currently being balloted. He encouraged the members to pass on all of their comments and necessary changes to the member country and include them in the response to the current ballot comments so that they could be considered at the next WG2 meeting.

6- Update the list of publications: This was done and the updated list is attached to these minutes.

7- Announcements and AOB: Mr. Goss asked Mr. Frank if he had any problems with ISO/DIS 15099 (Section 6.5.2 on meshing) having a more stringent (1%) accuracy requirement than ISO 10211-1 (2% given in Annex A.2, clause d) on the thermal transmittance/heat flow. Mr. Frank stated that he did not. Mr. Goss then stated that the WG2 members could ignore N250 where the 1% accuracy requirement was recommended to be changed to 2%.

8- Next meeting: The next meeting was scheduled for London (NPL) on 3 and 4 October 2000. Mr. Williams agreed to send to Mr. Elmahdy meeting room and Hotel information. Also, ISO TC163/WG14 will held on October 2 at NPL.

9- Adjournment: The meeting was adjourned at 16:30 hours on 9 May by Mr. Elmahdy after thanking Mr. Kuhnert for an excellent hosting of the meeting. Also, Mr. Elmahdy acknowledged the extensive efforts of Mr. Goss and the help from Mr. Wright for recording the minutes of the meeting and

List of Action Items for Review:

1 **Mr. Elmahdy will inform Ms. Andersson about all corrections and changes to the Master Mailing List.**
2 **Mr. Williams will again contact Mr. Anderson to get the latest ISO/FDIS 10077-1 table on glazing U-values.**
3 **Mr. Curcija will provide the frame calculations in tabular form using ISO/DIS 15099 for the entire prEN ISO/DIS 10077-2 Annex D profiles on Tuesday, 8 May 2000.**
4 **Mr. Goss will provide the revised Section 8.2.2 by the end of May, 2000.**
5 **Mr. Williams draft a letter with supporting tables and figures from N239 (updated as necessary by Mr. Wright) for Mr. Elmahdy to send to CEN TC 89 and ISO TC 160 through the ISO TC 163 Secretariat**
6 **Before sending the above letter, Mr. Elmahdy will contact the convenor of TC 160/SC1/WG2, Mr. Nothe, to see if it is possible to get the current revised draft of ISO 10292. If provided, Mr. Elmahdy will review the revised draft of ISO 10292 to see if any changes to the inappropriate glazing cavity convective heat transfer coefficient correlation have been made. If no revised draft is received, or no changes have been made in the revised draft of ISO 10292, Mr. Elmahdy will send the above letter to the TC 163 Secretariat to be forwarded to CEN TC 89 and ISO TC 160.**
7 **Mr. Hartmann will send to Mr. Elmahdy a revised version of N243rev with this revised table.**
8 **The members were all encouraged by Mr. Elmahdy to read the four technical papers related to the indoor radiation exchange models for projecting products, to digest the information and to come to the next meeting prepared to participate in the continued discussion.**

Attendees:

Mr. Kuhnert
Mr. Svendsen
Mr. Frank
Mr. Wright
Mr. Williams
Mr. van Dijk
Mr. Curcija
Mr. Shah
Mr. Feldmeier
Mr. Hartmann
Mr. Goss
Ms. Sorensen
Mr. Elmahdy

UPDATED LIST of DOCUMENTS

(N 200 to N258)

200. Letter from Margareta Andersson to TC163 members with a copy of ISO/CD 15099, dated 1997-12-08.
Distribution: Hakim Elmahdy

201. Fax message from Inger Jonssen dated 98-03-09 (from M.A.) including the comments received from the TC members on document N200 above (ISO/CD 15099).
Distribution: Hakim Elmahdy

202. WG2 response to ISO TC163 members with explanation of the rational to develop ISO 15099. The report was drafted during the WG2 meeting in Zurich.
Distribution: Hakim Elmahdy

203. Information about the Xenon gas properties. Hand out in Zurich meeting.
Distribution: Lars Olson.

204. An appendix outlining how to extract ASHRAE U-factor information from CEN/ISO U-value calculation.
Distribution: Bill Goss (handed out by Hakim Elmahdy).

205. The minutes of Zurich meeting, March 16-17, 1998.
Distribution: Hakim Elmahdy

206. Letter from WG2 to H. Froelich, H. Hartmann and CC to Ms. Andersson dated April 8, 1998, Re: request to proceed with the translation of CEN/ISO 10077-2
Distribution: Hakim Elmahdy

207. Fax from M. Andersson dated Sept. 13, 1998 in reply to H. Elmahdy.
Distribution: Hakim Elmahdy

208. Fax to H. Elmahdy dated Sept. 28, 1998 from P. Polato and F. Geotti-Bianchini (Stazione Sperimentale del Vetro).
Distribution: Mike Rubin

209. Working Draft 1 of ISO 15099 issued by ISO TC163/WG2, entitled: Windows and Doors-Thermal Transmission Properties-Detailed Calculation, Dated September 1998.
Distribution: Hakim Elmahdy

210. BSR/ASHRAE Standard 142, Proposed American National Standard, Standard Method for Determining and Expressing the Heat Transfer and Total Optical

Properties of Fenestration Products, Draft for Public Review, October 1996.
Distribution: Dragan Curcija for Daruish Arasteh.

211. CEN TC89 Thermal Performance of Buildings and Building Components, Working Draft, prEN ISO 10077-1: Thermal Performance of windows, doors, and shutters – calculation of thermal transmittance-part 1: simplified method. Dated Nov. 19, 1997.
Distribution: Thomas Frank

212. CEN/TC89/WG7 N114 document, Rev. 11 prEN 10077-2, dated 03-04-1998 Thermal performance of windows, doors and shutters – calculation of thermal transmittance – Part 2: Numerical methods for frames.
Distribution: Thomas Frank for Hans Hartman.

213. Comparison of Thermal Transmittance Calculation Methods Based on ASHRAE and CEN/ISO Standards, M.S. Thesis by Hartwig Roth, Mechanical Engineering Department, U. of Mass, May 1998.
Distribution: Bill Goss

214. Revised draft of Chapter 7 of ISO 15099 dated 9-23-1998, TNO, Delft, NL.
Distribution: Dick van Dijk

215. prEN ISO 10077-2 Annex D: Examples for Calculations
Distribution: Thomas Frank

216. Minutes of the September/October meeting at the University of Mass., Amherst, MA. September 30-October 1, 1998.
Distribution: Hakim Elmahdy

217. Anderson, B, R., The Thermal Resistance of Airspaces in Building Constructions Building and Environment, Vol. 1, No. 1, 1981.
Distribution: T. Frank

218. Goss, W. P. Outside Convective Heat Transfer Coefficient ($h_{outside}$) Calculations Showing the Differences Between Lokmanhekim (1975) and Kimura (1972, 1977), February, 1999.
Distribution: W. Goss

219. Ito, N., K. Kimura, J. Oka, A Field Experiment Study on the Convective Heat Transfer Coefficient on Exterior Surface of a Building. ASHRAE Transactions, Vol. 78, Part 2.
Distribution: W. Goss for K. Kimura.

220. Scientific Basis of Air-Conditioning, Applied Science Publishers, 1977.
Distribution: W. Goss for K. Kimura.

221. Sharples, S. Full-scale Measurements of Convective Energy Losses from Exterior Building Surfaces, Building and Environment, Vol. 19, No. 1, 1984.
Distribution: T. Frank

222. Yazdanian, M. and J. Klems, Measurement of the Exterior Convective Film Coefficient for Windows in Low Rise Building, ASHRAE Transactions, V. 100, Part 1, 1994.
Distribution: W. Goss

223. Letter from A. Burlingis to D. Curcija on turbulent convection formula from Folkin's textbook (in Russian).
Distribution: D. Curcija for A. Burlingas

224. Cole, R. and N. Sturrock, The Convective Heat Exchange at External Surface of Buildings, Buildings and Environment, Vol. 12, 1977.
Distribution: T. Frank

225. Memo from D, Arasteh to NFRC Members on Proposal to include THERM 2.0 in NFRC Procedures, April, 1999.
Distribution: B. Shah

226. Email from M. Andersson, Editorial comments on ISO/CD 15099 by A. Piggin and M. Andersson, 1999, April 12th.
Distribution: H. Elmahdy

227. The ALTSET Project, Angular Light and Total Solar Energy Transmittance, February, 1999.
Distribution: D. van Dijk

228. Minutes of the April 1999 meeting at the Swedish National Testing and Research Institute, Boras, Sweden, 26 - 28 April 1999.
Distribution: Hakim Elmahdy

229. Solar transmittance of shading devices; bidirectional calculation versus simplified BD method.
Distribution: D. van Dijk

230. Comments received for ISO/CD15099
Distribution: Hakim Elmahdy

231. French Comments
Distribution: Hakim Elmahdy

232. Report to ISO/TC 163 Committee from ISO/TC 163/WG2 July 16, 1999

Distribution: Hakim Elmahdy

233. Comparison of calculated and measured U values
Distribution: Svend Svendsen

234. Updated mailing list for ISO/TC 163/WG2 Thermal transmission properties of Windows
Distribution: Hakim Elmahdy

235. Minutes of the Berlin Meeting
Distribution: Hakim Elmahdy

236. Agenda for the Vienna meeting, May 8-9, 2000.

Distribution: Hakim Elmahdy

237. Section 8.2.2 of ISO 15099, Convective Heat Transfer Coefficient-outdoor side
Distribution: Hakim Elmahdy

238. Annex B - Thermophysical fill gas property values
Distribution: Bill Goss

239. Comparison of ISO 15099 and prEN ISO 10077-1. Letter from John Wright to Hakim Elmahdy dated April 17, 2000.
Distribution: Bill Goss

240. Analysis of calculated and measured energy properties of windows, PTQ Report SR-0010, February 2000
Distribution: Svend Svendsen

241. Comparison of calculations of thermal transmittance of windows using two and three dimensional models, paper by P. Weitzmann, C. Jensen and S. Svensen
Distribution: Svend Svendsen

242. Evaluation of FRAME 4 for use with prEN ISO 10077-2, Report by Enermodal Engineering, March 2000.
Distribution: Hakim Elmahdy (Steve Carpenter)

243. Results of the comparison calculations on frame sections in connection with prEN ISO 100777-2 CEN/TC 89 N198, February 5, 2000.
Distribution: H. Hartmann

244. BISCO validation according to prEN ISO 10077-2 Annex D, Draft version, February 4, 2000
Distribution: P. Standaert

245. Summary of comments on prEN ISO 10077-2 "Thermal performance of windows, doors and shutters- Calculation of thermal transmittance - part 2: Numerical method for frames"
Distribution: DIN, Berlin.

246. Report on the joint meeting of ISO/TC163/WG2 and CEN/TC89/WG7 in Berlin on September 13-14, 1999
Distribution: DIN, Berlin

247. Resolutions of the 14th meeting of ISO/TC163 held on September 17, 1999 in Berlin, Germany, ISO/TC 163 N352 E, December 15, 1999
ISO TC 163 Secretariat

248. Results of voting on ISO CD 15099-2, Windows and Doors, Thermal transmission properties, Detailed calculations, ISO/TC 163 N350 rev, December 15, 1999
Distribution: ISO TC 163 Secretariat

249. Report of voting CD 15099-2, December 6, 1999, ISO TC163/WG2., TC163 N338
Distribution: ISO TC 163 Secretariat

250. Section 6.5 Geometric representation and meshing
Distribution: Bill Goss

251. A simplified analysis of radiant heat loss through projecting fenestration products, Draft ASHRAE paper by John Wright
Distribution: John Wright

252. Two figures on Nu and Ra Correlations
Distribution: John Wright

253. Effect of realistic boundary conditions in computer modelling of condensation resistance for fenestration systems, ASHRAE paper by D. Curcija
Distribution: Dragan Curcija

254. Improving computer simulations of heat transfer for projecting fenestration products: using radiant view factor models, ASHRAE paper by B. Griffith, D. Curcija, D. Turler and D. Arasteh.
Distribution: Dragan Curcija.

255. Guidelines for modeling projecting fenestration projecting fenestration products, ASHRAE paper by D. Arasteh, E. Findlayson and D. Curcija.
Distribution: Dragan Curcija.

256. ISO /DIS 15099 Thermal performance of windows, doors and shading devices-detailed calculations
Distribution: ISO TC163 Secretariat

257. Results of numerical frame calculations, May 2000 by M. Spiekman.
Distribution: Dick van Dijk

258. Minutes of ISO TC163/WG2 meeting in Vienna, Austeria, May 8-9, 2000.
Distribution: Hakim Elmahdy